

## 4 Action Area and Environmental Baseline

### 4.1 Introduction

This chapter describes the action area of the proposed action (PA) as well as the environmental baseline in the action area, including an overview of environmental conditions and a description of the effects of these conditions on the species included in this biological assessment. Detailed species accounts for each species considered in this BA are provided in Appendix 4.A, *Status of the Species and Critical Habitat Accounts*.

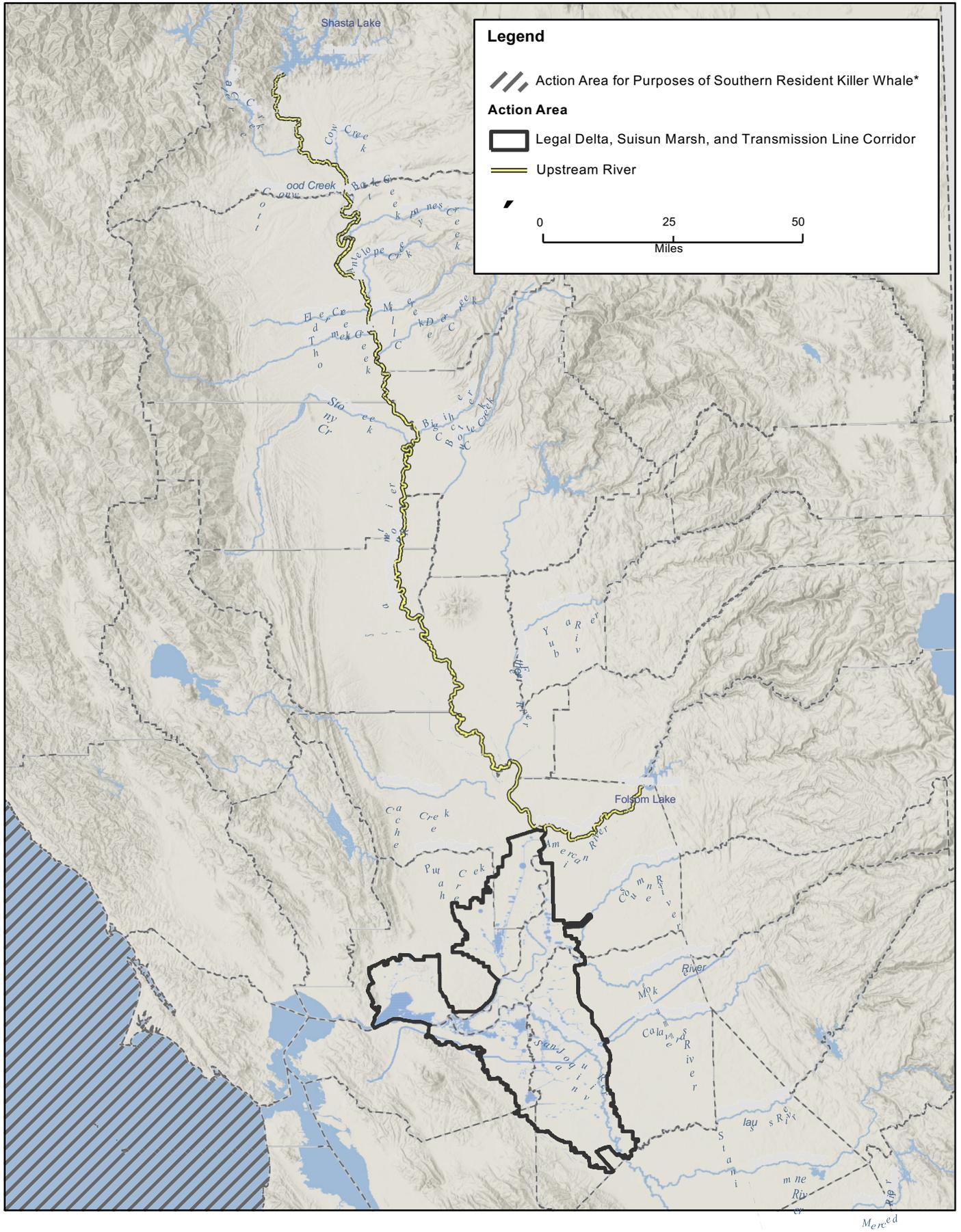
### 4.2 Action Area

The action area is defined as all areas to be affected directly or indirectly by the Federal action, and not merely the immediate area involved in the action (50 CFR §402.02). For purposes of this consultation, the action area includes the entire legal Delta, Suisun Marsh, and Suisun Bay; and extends upstream within the channels of the Sacramento and American Rivers below Keswick and Nimbus Dams, respectively Figure 4-1. For purposes of the Southern Resident distinct population segment (DPS) of killer whale only, the action area includes nearshore coastal areas in California, Oregon, and Washington<sup>1</sup> (Figure 4-2).

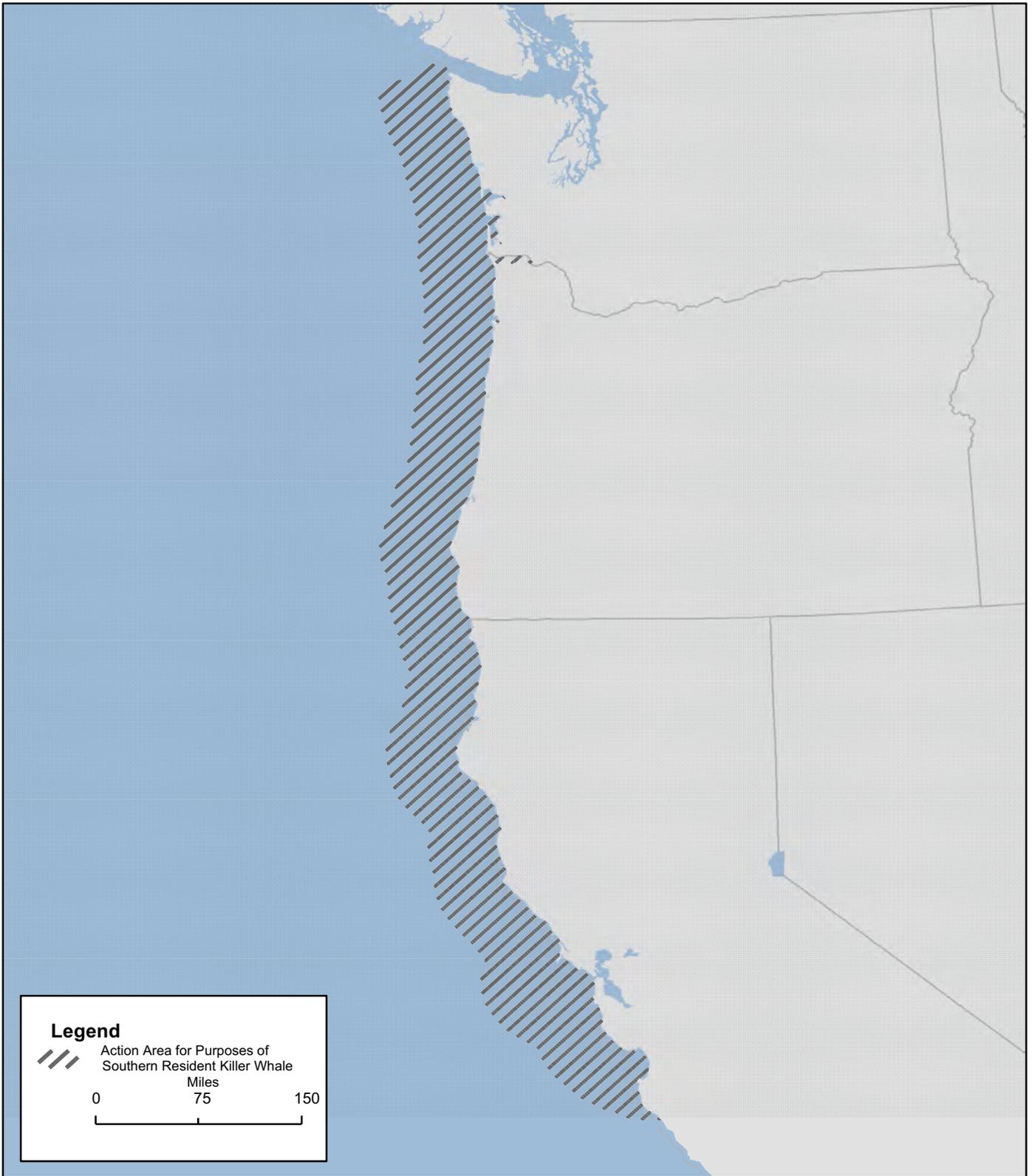
The action area was derived considering several factors to account for all effects of the PA. First, to determine the action area for listed fish and their designated critical habitat, the CALSIM II model was used to screen for the extent of potential direct and indirect effects within the Sacramento and San Joaquin Rivers and their tributaries. Where CALSIM II results did not differ between the PA and No Action conditions, no effect was assumed within the Sacramento and San Joaquin Rivers and their tributaries because it indicates that the PA would not have an effect on operations, and therefore would not affect species in those areas. Where CALSIM II results did not differ between the PA and No Action conditions, it was assumed that the PA did not cause an effect, and that the action area did not need to include those areas. This is discussed further in the introduction to Section 5.4.2, *Upstream Hydrologic Changes*, which describes the tributaries that are part of the SWP/CVP with no difference between PA and No Action are the Trinity River, Clear Creek, the San Joaquin River, and the Stanislaus River; these areas therefore were excluded from the action area. Additionally, the Feather River system is excluded from the action area due to the existing formal consultation on water operations in that system, as detailed in Section 4.4 *Feather River Operations Consultation*. The entire legal Delta and Suisun Marsh are included in the action area for fish species because the PA may affect any waterway in the Delta or Suisun Marsh. Detailed modeling results are provided as Appendix 5.A, *CALSIM Methods and Results*. For listed species of wildlife, the entire legal Delta was assumed to account for all of the potential construction effects, including the siting of offsetting measures including habitat restoration. For the Southern Resident killer whale, all nearshore coastal waters within their range in California, Oregon, and Washington are included in the action area because this distribution is consistent with the description provided by NMFS (2009: 158-160).

<sup>1</sup> Note that the Puget Sound is not included in the PA Action Area.





**Figure 4-1**  
**California WaterFix Action Area**



**Figure 4-2**  
**California Water Fix Action Area for Purposes of Southern Resident Killer Whale**

### 4.3 Environmental Context

This section includes a general description of environmental conditions in the action area to provide relevant background information for the environmental baseline. The environmental baseline for each species is presented below in Section 4.5, *Status of the Species/Environmental Baseline Summary*.

#### 4.3.1 Historical Conditions

Much of the broad scale geology of the Central Valley, Delta, and Suisun Marsh was formed before the Pleistocene epoch (more than 2 million years ago), while finer details wrought by younger geologic formations, including the recent uplift and movement of the Coast Range and the deposition of broad alluvial fans along both sides of the Central Valley, formed during the Pleistocene epoch from 2 million to 15,000 years ago (Louderback 1951; Olmsted and Davis 1961; Lydon 1968, Shlemon 1971; Atwater et al. 1979; Marchandt and Allwardt 1981; Helley and Harwood 1985; Band 1998; Unruh and Hector 1999; Graymer et al. 2002; Weissmann et al. 2005; Unruh and Hitchcock 2009). Approximately 21,000 years ago, the last glacial maximum ended and the eustatic (worldwide) sea level began to rise from the lowstand (lowest sea level bathymetric position or depth during a geologic time) of -394 feet (-120 meters) in a series of large meltwater pulses interspersed by periods of constant rising elevation. The rise continued until the Laurentide ice sheet had completely melted 6,500 years ago and the rate of sea level rise slowed dramatically (Edwards 2006; Peltier and Fairbanks 2006). During this change from glacial to interglacial period, runoff brought enormous quantities of sediment from the Sierra Nevada and Coast Range that formed alluvial fans and altered stream channels in the Central Valley (Olmsted and Davis 1961; Shlemon 1971; Marchandt and Allwardt 1981; Helley and Harwood 1985; Weissmann et al. 2005).

The modern Delta formed sometime between 10,000 and 6,000 years ago, when the rising sea level inundated a broad valley that occupied the Delta region. Despite its name, the Sacramento–San Joaquin River Delta is not simply the merging of two river deltas, but is instead an elongated and complex network of deltas and flood basins with flow sources that include Cache Creek, Putah Creek, Sacramento River, Mokelumne River, San Joaquin River, and Marsh Creek. Based on current unimpaired flow estimates, the Sacramento River is the largest source of flows and has contributed an average of 73% of historical inflows into the Delta. The eastside tributaries, including the Mokelumne River, contribute about 6%, and the San Joaquin River contributes 21% (California Department of Water Resources 2007).

Currently, during high-flow events (when water from the Sacramento River spills into the bypasses), approximately 80% of Sacramento River flow enters the Yolo Bypass, a flood control bypass west of the city of Sacramento, via the Fremont Weir (Roos 2006). Flows begin to enter Fremont Weir when Sacramento River flows at Freeport exceed 56,000 cubic feet per second (cfs). The flood stage flows can have many sources, including direct flows from tributaries such as the Feather and American Rivers, as well as flows transiting a system of passive and active weirs (James and Singer 2008; Singer et al. 2008; Singer and Aalto 2009). The Yolo Bypass also serves as a conduit for Cache Creek and Putah Creek, as their waters enter the Sacramento River via Cache Slough at the southern end of the Yolo Bypass. The San Joaquin River discharges into a broad network of sloughs and channels, and the Mokelumne River delta merges with the San

Joaquin River delta on the eastern side of the Delta. On the southwest side of the Delta, the Marsh Creek delta merges with the San Joaquin River delta.

While flooding has always been a regular occurrence along the Sacramento River (Thompson 1957, 1960, 1961, 1965), the natural geomorphic processes and hydrologic regimes were completely disrupted by the enormous increase in sediment and debris generated by hydraulic mining operations in the central Sierra Nevada from 1853 to 1884 (Gilbert 1917; Mount 1995). Large volumes of mining sediment remain in the tributaries today (James 2004a; 2004b). The portion of the estimated 1.5 billion cubic feet of sediment that poured into the Sacramento Valley filled river channels and increased flooding severity and peak flows (Gilbert 1917; Kelley 1989; Mount 1995; James 2004a; Hitchcock et al. 2005; William Lettis & Associates 2005; James 2006; Central Valley Regional Water Quality Control Board 2008; James and Singer 2008; James et al. 2009). In the 1900s, another pulse of mining sediment was discharged into the Sacramento River watershed (James 1999). While it is often assumed the mining sediment has already passed through the Delta or is stored behind dams, large amounts remain within the system (James 1999, 2004a, 2004b, 2006; James and Singer 2008; James et al. 2009). Other Central Valley streams, such as the Cosumnes River, have been affected to a lesser extent by similar mining or agriculture-derived sources of sediment (Florsheim and Mount 2003). Historically, the initial pulse of sediment made its way into the San Francisco Estuary where it filled shallow tidal bays. However, with current reduced sediment loads into the estuary, the remaining sediments in the estuary are being eroded and transported into the Pacific Ocean (Cappiella et al. 1999; Ganju and Schoellhamer 2010).

Soils in the Delta are extremely variable in texture and chemical composition. In the interior of the Delta, soils are generally a combination of peat beds in the center of islands with relatively coarse textured inorganic sediments deposited in the channels and along the margins of the islands (William Lettis & Associates 2005; Unruh and Hitchcock 2009; Deverel and Leighton 2010). Ancient dune deposits on the islands and shoreline of the western Delta near the San Joaquin River predate the peat beds (Carpenter and Cosby 1939; San Francisco Estuary Institute 2010). The soils in the Suisun Marsh area are generally peat or fine textured mineral soils in and along the islands closest to Suisun Bay, and fine textured mineral soils are found closer to the border of the marsh where it abuts the uplands. The soils of the Cache Slough area are primarily mineral soils that are either fine-textured and of local origin, or coarse-textured material that is a legacy of gold mining in the Sierra Nevada and streams leading from the Sierra Nevada. The uplands north of Suisun Marsh and west of the Sacramento River are generally alkaline clays (Mann et al. 1911; Bryan 1923; Thomasson Jr. et al. 1960; Graymer et al. 2002). The soils of the Yolo Basin are alkaline clays on the west side, a mixture of clay, sand, and peat on the bottom of the basin, and silts with sand splays on the natural levee of the Sacramento River (Anonymous 1870; Mann et al. 1911; Andrews 1972). The soils along the southwestern border of the Delta are sands to the north and alkaline clays to the south (Carpenter and Cosby 1939; Natural Resources Conservation Service 2009; San Francisco Estuary Institute 2010). Along the eastern border of the Delta, the soils are heterogeneous patches of clays, loams, and peat (Florsheim and Mount 2003; Natural Resources Conservation Service 2009).

It is estimated that prior to reclamation actions (filling, levee construction, diking, and draining), nearly 60% of the Delta was inundated by daily tides. The tidal portion of the Delta consisted of backwater areas, tidal sloughs, and a network of channels that supported highly productive

freshwater tidal marsh and other wetland habitats (Whipple et al. 2012). Similar complex drainage networks, ponds, and salt panes existed in tidal brackish marshes in Suisun Marsh and along the north shore of east Contra Costa County (Brown 2004; Whipple et al. 2012; San Francisco Estuary Institute 2010). The soils in these marshes were generally peat beds that accumulated and were preserved under anoxic conditions. In contrast, soils in channels and along the higher-energy channel margins of islands tend to be composed primarily of mineral sediment (William Lettis & Associates 2005; Unruh and Hitchcock 2009).

Reclamation occurred over vast areas in the Delta, Yolo Basin, Suisun Marsh, and the south shore of Suisun Bay between the 1850s and the early 1930s, completely transforming their physical structure (Thompson 1957, 1965; Suisun Ecological Workgroup 2001; Brown 2004; Whipple et al. 2012; San Francisco Estuary Institute 2010). Levee ditches were built to drain land for agriculture, human habitation, mosquito control, and other human uses while channels were straightened, widened, and dredged to improve shipping access to the Central Valley and to improve downstream water conveyance for flood management. During this period, over 300,000 acres of tidal marshes in the Delta were diked, drained, and converted to agriculture (Atwater et al. 1979). Thus, the complex, shallow, and dendritic marshlands were replaced by simplified, deep, and barren channels. This hydrogeomorphic modification fragmented aquatic and terrestrial habitats, and decreased the value and quantity of available estuarine habitat (Herbold and Vendliniski 2012; Whipple et al. 2012).

Floodplain includes areas that are inundated by overbank flow during the winter and spring peak flows. Inundation can last for up to several months. In presettlement times, floodplain was arguably one of the most productive natural communities in the Delta, and its loss can be linked to the decline of many native Delta species. Reclamation, channel modification for flood control, and water removals for agriculture and export have resulted in a substantial reduction in floodplain areas. Floodplains provide important habitat for rearing, migrating, and adult fish; migratory waterfowl; and amphibians, reptiles, and mammals native to the Delta.

Under natural conditions, inflows from both the Sacramento and San Joaquin Rivers to the Delta were much lower from July through November compared to the December to June period (The Bay Institute 1998), and in drought periods likely led to salinity intrusions. This difference was more dramatic in the San Joaquin River. The San Joaquin River has an upper watershed consisting of impermeable granitic rock that does not support dry season groundwater discharge. In contrast, the upper watershed of the Sacramento River is composed of permeable volcanic rock. As a result, groundwater discharge from this volcanic system historically maintained a summer base flow at Red Bluff of approximately 4,000 cfs, without which the Sacramento River would have nearly dried up each fall (The Bay Institute 1998).

Water diversions in the San Joaquin Valley began earlier than those in the Sacramento Valley, and by 1870, flows of the San Joaquin River were significantly reduced (California Department of Water Resources 1931; Jackson and Patterson 1977). Sacramento River diversions, particularly late spring and summer diversions for rice irrigation, increased dramatically from 1912 to 1929. The combination of significant drought periods and increased diversion during the annual low-flow period resulted in an unprecedented salinity intrusion into the Delta in fall 1918 (California Department of Water Resources 1931; Jackson and Patterson 1977; The Bay Institute 1998; Contra Costa Water District 2010). The economic impacts of these diversion-caused

saltwater intrusions ultimately led to the creation of the Central Valley Project (CVP) and the construction of dams for the storage and release of fresh water to prevent salinity intrusion (Jackson and Patterson 1977). Between the 1930s and 1960s, construction of dams and diversions on all major rivers contributing to the Delta resulted in substantial changes to Delta hydrodynamics (The Bay Institute 1998; Contra Costa Water District 2010). Four dams (Shasta, Oroville, Trinity, and Monticello) in the Sacramento Valley have individual storage capacities greater than 1 million acre-feet (af) (12 million af total); an additional four dams (New Melones, Don Pedro, New Exchequer, and Pine Flat) with storage capacities greater than 1 million af (6.5 million af total) drain into the San Joaquin Valley (California Department of Water Resources 1993).

The main effect of this upstream water development was the dampening of the seasonal high flows during the winter and spring and low flows during the fall into the Delta (Contra Costa Water District 2010). Reclamation of the Delta and upstream water development also accentuated salinity intrusions into the Delta. Current water management regulations have reduced the annual fluctuations in saltwater intrusion but have also shifted the boundary between fresh and salt water farther into the Delta (Contra Costa Water District 2010). Reclamation, dam construction, flood management, and water projects have greatly transformed the geometry and hydrology of the Delta, as well as downstream locations including Suisun Bay and Suisun Marsh (California Department of Water Resources 2013a).

## **4.3.2 Physical Environment**

### **4.3.2.1 Climate Conditions**

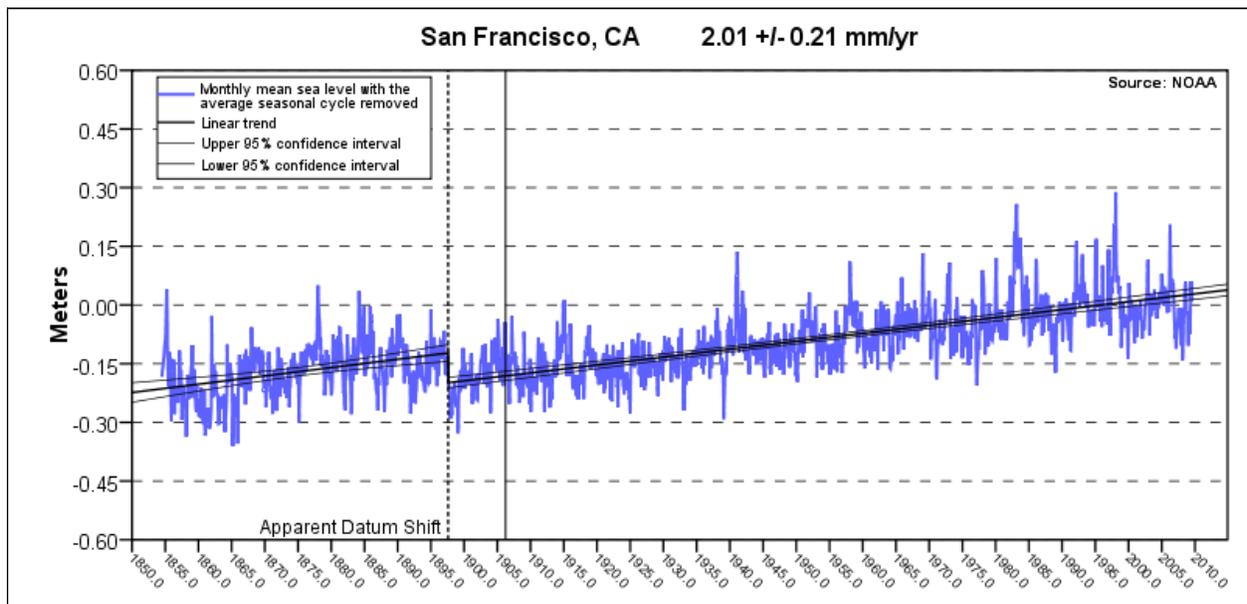
The climate in the Sacramento–San Joaquin Delta region is spatially variable, but is generally characterized as hot Mediterranean (Köppen climate classification) (Kottek et al. 2006). The general climate becomes milder from east to west due to marine influence as it is affected by winds off the Pacific Ocean.

Summers are hot with average summer highs in the upper 80 degrees Fahrenheit (°F) to lower 90°F, with little to no precipitation and low humidity. Heat waves are common in summer months, during which temperatures can reach triple digits for consecutive days. Periodically, a “Delta breeze” of cool and humid air from the ocean moves onshore and cools the Central Valley in the vicinity of the Delta by up to 7°F (3.9 degrees Celsius [°C]) (Pierce and Gaushell 2005). Winters are mild (average daily highs during November through March are in the mid-50 to mid-60°F) and wet. Approximately 80% of annual precipitation occurs from November to March. The primary origin of precipitation is the seasonal arrival of low-pressure systems from the Pacific Ocean. Very dense ground fog (tule fog) is common between periods of precipitation in the Delta from November through March.

The climate of the Delta is predicted to change in complex ways. Although there is high uncertainty, temperatures in the Delta are projected to increase at an accelerating pace from 3.6 to 9°F (2 to 5°C) by the end of the century (Cayan et al. 2009). Depending upon the general-circulation model used, there are variable predictions for precipitation change, with most models simulating a slight decrease in average precipitation (Dettinger 2005; California Climate Change Center 2006). The Mediterranean seasonal precipitation experienced in the Delta is expected to

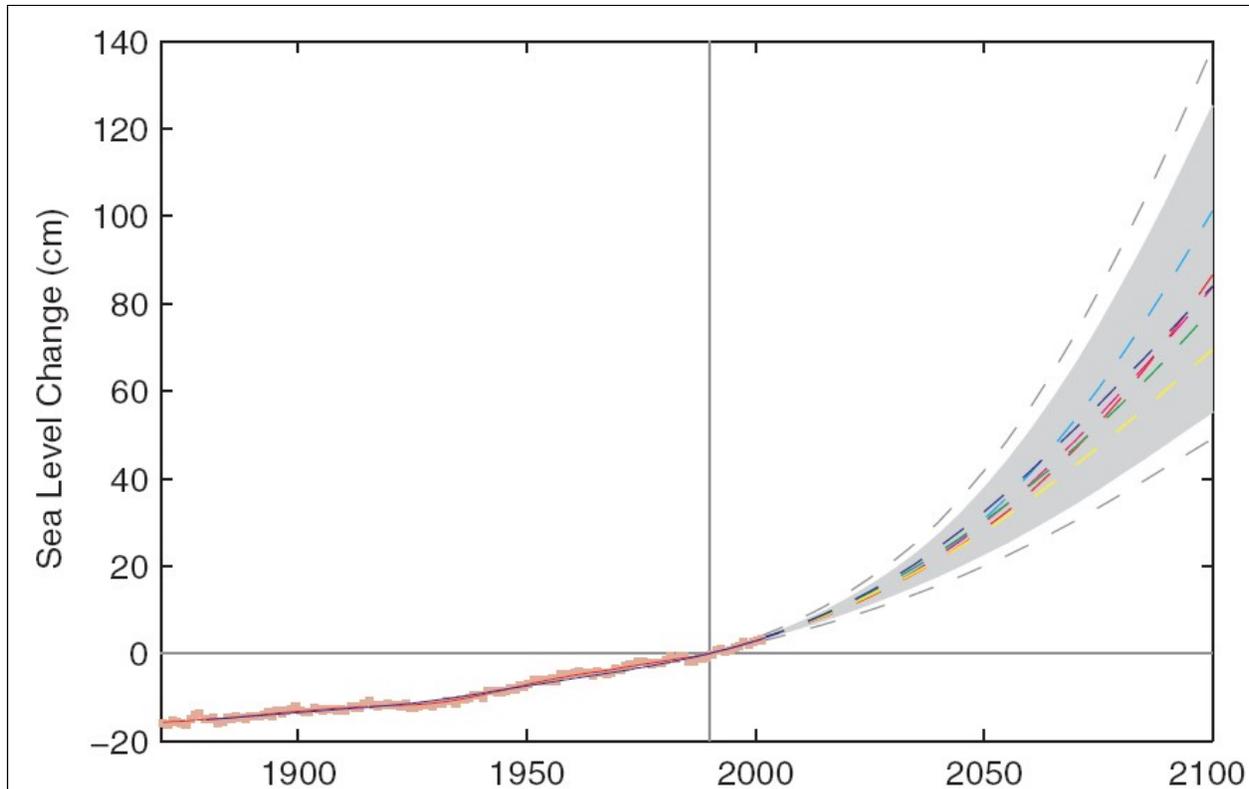
continue, with most precipitation falling during the winter season and originating from North Pacific storms. Although the amount of precipitation is not expected to change dramatically over the next century, seasonal and interannual variation in precipitation will likely increase as it has over the past century (California Department of Water Resources 2006). This could lead to more intense winter flooding, greater erosion of riparian habitats, and increased sedimentation in wetland habitats (Field et al. 1999; Hayhoe et al. 2004).

Rahmstorf (2007) used a semi-empirical approach to project future sea level rise, yielding a projected sea level rise of 1.6 to 4.6 feet above 1990 levels by 2100 when applying the Third Assessment Report warming scenarios. Other recent estimates indicate global increases by 2100 of 1.6 to 3.3 feet (National Research Council 2010); 2.6 to 6.6 feet (Pfeffer et al. 2008); and 3.2 to 5.1 feet (Vermeer and Rahmstorf 2009) (Figure 4-3 and Figure 4-4).



Source: National Oceanic and Atmospheric Administration 2009

**Figure 4-3. Observed Mean Sea Level Trend for the San Francisco Tide Gage near the Golden Gate**



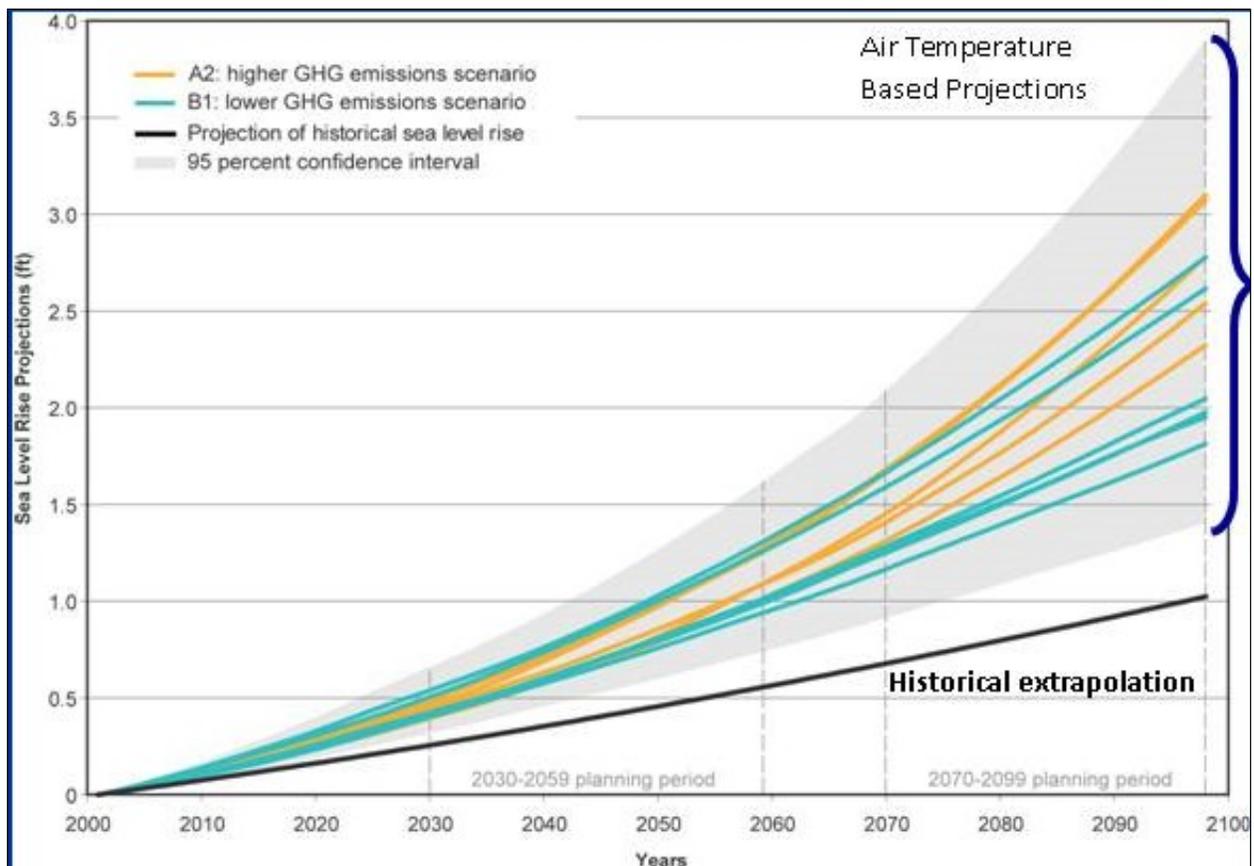
Source: Rahmstorf 2007

**Figure 4-4. Past Global Mean Sea Level and Future Mean Sea Level Based on Global Mean Temperature Projections**

Using the Rahmstorf (2007) method, the CALFED Bay-Delta Program (CALFED) Independent Science Board estimated ranges of sea level rise of 2.3 to 3.3 feet at midcentury and of 1.6 to 4.6 feet by the end of the century (CALFED Independent Science Board 2007). Some tidal gage and satellite data indicate that rates of sea level rise are increasing (Church and White 2006; Beckley et al. 2007). Scenarios modeled by the California Climate Action Team projected sea level rise increases along the California coast of 1.0 to 1.5 feet above 2000 levels by 2050 and 1.8 to 4.6 feet by 2100 (Cayan et al. 2009). However, if California's sea level continues to mirror global trends, increases in sea level during this century could be considerably greater. Increasing sea levels will seriously threaten the integrity of the Delta's levees and conveyance of water supplies through the Delta (Florsheim and Dettinger 2007).

For water planning purposes, the California Department of Water Resources (DWR) estimated sea level rise over the 21st century using the method of Rahmstorf (2007) and 12 climate projections selected by the California Climate Action Team (Chung et al. 2009). The historical 95% confidence interval was extrapolated to estimate the uncertainties in the future projections (Figure 4-5). Midcentury sea level rise projections ranged from 0.8 to 1.0 foot, with an uncertainty range spanning 0.5 to 1.2 feet. End-of-century projections ranged from 1.8 to 3.1 feet, with an uncertainty range of 1.0 to 3.9 feet. These estimates are slightly lower than those of Rahmstorf (2007) because DWR used a more limited ensemble of climate projections that did not include the highest projections of temperature increases (Chung et al. 2009).

Parker et al. (2011) observed that, in the Bay-Delta, other factors complicate sea level rise projections, including the Pacific Decadal Oscillation (PDO) and El Niño Southern Oscillation (ENSO) events. The PDO is characterized by cool or warm phase shifts in North Pacific sea surface temperatures that commonly persist for 20 to 30 years. Superimposed on the PDO cycles are smaller-scaled El Niño and La Niña events that persist for about a year. Climatic impacts associated with La Niña events are similar to those tied to the cool PDO phases, and climate conditions related to El Niño episodes parallel those of warm PDO phases. Parker et al. (2011) observed that rates of sea level rise slow during the negative (cool) phase and increase during the positive (warm) phase. They also noted that fluctuations in sea level rise, when combined with processes such as ENSO events, may have a greater effect on wetlands than a steady increase.



Source: Chung et al. 2009.

**Figure 4-5. DWR-Generated Future Sea Level Rise Projections for the Bay Delta Using the Rahmstorf Method and Regionally Downscaled Data**

Increasing sea level rise will increase saltwater intrusion into the Sacramento–San Joaquin River Delta (Delta), disrupting marsh and estuary ecosystems and reducing freshwater and terrestrial plant species habitat. Increased salinity also may increase mortality for species that are sensitive to salinity concentrations. Changes in salinity levels may place added stress on other species, reducing their ability to respond to disturbances. Increased frequency and severity of flood events combined with sea level rise can relocate species and damage or destroy species habitat. Lower ecosystem productivity from increased salinity will affect both phytoplankton-based and detritus-based foodwebs (Parker et al. 2011).

Sea level rise is predicted to be an especially significant factor in in the legal delta within the action area, where much of the land has subsided to below sea level and is protected from flooding by levees. In the Delta, sea level rise in combination with ongoing subsidence of Delta islands will increase the instability of the Delta's levee network, increasing the potential for island flooding and sudden landscape change in the Delta over the next 50 years (Mount and Twiss 2005). The current subsided island condition, combined with higher sea level, increased winter river flooding, and more intense winter storms, will significantly increase the hydraulic forces on the levees. With sea level rise exacerbating current conditions, a powerful earthquake in the region could collapse levees, leading to major seawater intrusion and flooding throughout the reclaimed lands of the Delta, altering the tidal prism, and causing substantial changes to the tidal perennial aquatic natural community (Mount and Twiss 2005; Florsheim and Dettinger 2007).

Predicted warmer temperatures will affect the rate of snow accumulation and melting in the snowpack of the Sierra Nevada. Some projections predict reductions in the Sierra Nevada spring snowpack of as much as 70 to 90% by the end of the century (California Climate Change Center 2006). Knowles and Cayan (2002) estimated that a projected warming of 3°F (1.6°C) by 2060 would cause the loss of one-third of the watershed's total April snowpack, whereas a 4°F (2.1°C) warming by 2090 would reduce April snowpack by 50%. Recent literature indicates a general decline in the April 1 snow water equivalent for the Pacific Northwest and northern Sierra locations, and increases in parts of the southern Sierra (Mote et al. 2008, Pederson et al 2011, Pierce et al. 2008). Measurements taken to track the water content of snow (snow water equivalent) since 1930 show that peak snow mass in the Sierra Nevada has been occurring earlier in the year by 0.6 day per decade (Kapnick and Hall 2009). These predicted changes in the dynamics of the snowpack will influence the timing, duration, and magnitude of inflow from the Sacramento and San Joaquin River watersheds. For example, with more precipitation falling as rain instead of snow and the snowpack melting earlier, greater peak flows will result during the rainy season and lower flows during the dry season. Knowles and Cayan (2004) predict that inflows will increase by 20% from October through February and decrease by 20% from March through September, compared to current conditions. Storm surges (tidal and wind-driven) associated with the more intense storms predicted for the future will also exacerbate Delta flooding. On April 1, 2015, DWR found no snow at the Phillips snow course during its early-April measurements. This was the first time in 75 years that no snow was found there. Readings found that the statewide snowpack held only 5% of the historical average of water content for April 1 (California Department of Water Resources 2015).

#### **4.3.2.2 Hydrologic Conditions**

The hydrology of the Delta is primarily influenced by tides, Delta inflow and outflow, diversion, and Delta Channel configuration (California Department of Water Resources 1999). Delta inflows are governed by several existing regulations including the current NMFS biological opinion (BiOp) (2009) for long-term coordinated operations of the CVP/SWP. The effects of these operations on fish are described in the species accounts included in Section 4.5, *Status of the Species/Environmental Baseline Summary*, and in Appendix 4.A, *Status of the Species and Critical Habitat Accounts*. The Delta receives runoff from a watershed that includes more than 40% of the state's land area including the Sacramento, San Joaquin, Mokelumne, Cosumnes, and Calaveras River tributaries.

#### 4.3.2.2.1 *River Hydrology*

Multiple upstream tributaries to the Sacramento and San Joaquin Rivers influence flow into the Delta. The Feather and American Rivers and many large creeks drain directly into the Sacramento River, while the Cache and Putah Creeks drain into the Yolo Bypass, which joins the Sacramento River in the Cache Slough area. The Yuba and Bear Rivers drain into the Feather River before its confluence with the Sacramento River. The Calaveras, Stanislaus, Tuolumne, Merced, and Kings Rivers drain into the San Joaquin River upstream of the Delta. Eastside streams, particularly the Mokelumne River, also contribute inflows to the Delta. The Cosumnes River drains directly into the Mokelumne River, and both drain into the San Joaquin River after entering the Delta. In addition to the Sacramento and San Joaquin Deltas, the Mokelumne Delta in some ways can be viewed as a third important river delta.

Regardless of water year type<sup>1</sup>, the large majority of unimpaired upstream flow into the Delta originates from the Sacramento River and its tributaries, and a lesser extent originates from the San Joaquin River and its tributaries. The Cosumnes and Mokelumne Rivers and other smaller tributaries, collectively called the eastside tributaries, contribute only a small percentage of inflows.

Numerous upstream dams and diversions greatly influence the timing and volume of water flowing into the Delta from rivers and tributaries. These values vary by water-year type and the inflows associated with the water year. For example, in the 2000 water year, an above-normal water year, 69% of water entering the Delta passed through the system as outflow, 6% was consumed within the Delta, less than 1% was diverted via the North Bay Aqueduct and by Contra Costa Water District (CCWD), and 24% was exported via CVP/SWP facilities. Additional water was withdrawn upstream of the Delta via upstream diversions and reservoirs, accounting for an additional 7,525 thousand af (California Department of Water Resources 2008). For comparison, in the 2001 water year, a dry year, approximately 51% of water entering the Delta passed through the system as outflow, 12% was consumed within the Delta, and 37% was exported via CVP/SWP facilities. Kimmerer (2002) shows that the proportion of inflow exported by the CVP/SWP decreases as inflow increases. As inflow decreases, the relationship between inflow and outflow strengthens because CVP/SWP exports can capture a larger proportion of the inflow (Kimmerer 2002a). Much of the precipitation that contributes to Delta inflow originates from the Sacramento River and its tributaries (85% median contribution), with smaller contributions from the San Joaquin River and its tributaries (11% median contribution) (Kimmerer 2002a).

The hydrograph of the Delta is highly variable both within and across years. Within years, water flow is generally greatest in winter and spring with inputs of wet season precipitation and snowpack melt from the Sierra Nevada and lowest during fall and early winter before significant rainfall. The construction of upstream dams and reservoirs for flood protection and water supply has dampened the seasonal variation in flow rates. Water is released from reservoirs year-round, and flooding is much less common than it was before dam and levee construction. As a result, the frequency of small- to moderate-sized floods has been significantly reduced since major dam

<sup>1</sup> Water-year type is determined using the Water Supply Index at <<http://cdec.water.ca.gov/cgi-progs/iodir/WSI.2015>>

construction, although the magnitude and frequency of large floods has not been significantly altered. Additionally, because of climatic changes, there have been more large floods in the last 50 years than the 50 years before then. Across years, extended wet and dry periods (defined as periods during which unimpaired runoff was above or below average, respectively, for 3 or more years) occurred numerous times in the last 100 years, and the duration and magnitude of extended wet and dry periods have increased in the last 30 years. This includes the 6-year drought of 1987 to 1992 and the prolonged periods of wetness in the early- to mid-1980s and middle-to-late 1990s (California Department of Water Resources 2007). As of 2015, California is currently in its fourth consecutive year of below-average rainfall and very low snowpack. The wet and dry periods recorded over the last 150 years, however, are less severe and shorter than the prolonged wet and dry periods of the previous 1,000 years.

The Yolo Bypass is an important physical feature affecting river hydrology during high-flow events in the Sacramento River watershed. The bypass is a 59,280-acre engineered floodplain that conveys flood flows from the Sacramento River, Feather River, American River, Sutter Bypass, and western tributaries and drains (Harrell and Sommer 2003). The leveed bypass protects Sacramento and other nearby communities from flooding during high-water events and can convey up to 80% of flow from the Sacramento basin during flood events (Sommer et al. 2001a). Most water enters the Yolo Bypass by spilling over the Fremont and Sacramento weirs and returns to the Sacramento River in the Delta approximately 5 miles upstream of Rio Vista. The Yolo Bypass floods seasonally in approximately 60% of years (Sommer et al. 2001b).

#### **4.3.2.2.2 Tides**

The Delta, lower portion of the Yolo Bypass, and Suisun Marsh are tidally influenced by the Pacific Ocean, although tidal range and influence decrease with increasing distance from the San Francisco Bay (Kimmerer 2004). Tides are mixed semidiurnal with two highs and two lows each day (i.e., one larger magnitude high and low and one lower magnitude high and low). A typical diurnal range is 3.3 to 4.6 feet (1 to 1.4 meters) in the western Delta (Orr et al. 2003). The entire tidal cycle is superimposed upon the larger 28-day lunar cycle with more extreme highs and lows during spring tides and depressed highs and lows during the neap tides. In addition, annual tidal elevations are highest in February and August. The multiple temporal scales at which these cycles occur causes significant variation in draining and filling of the Delta, and therefore, in patterns of mixing of the waters (Kimmerer 2004). Additionally, variation in mean sea level can also be caused by changes in atmospheric pressure and winds (Department of Water Resources 2013b).

#### **4.3.2.2.3 Water Supply Facilities and Facility Operations**

Over 3,000 diversions remove water from upstream and in-Delta waterways for agricultural, municipal, and industrial uses; 722 of these are located in the mainstem San Joaquin and Sacramento Rivers and 2,209 diversions are in the Delta (Herren and Kawasaki 2001). The CVP, managed by the Bureau of Reclamation (Reclamation), and SWP, managed by DWR, use the Sacramento and San Joaquin Rivers and other Delta channels to transport water from river flows and reservoir storage to two water export facilities in the south Delta (Figure 4-6). The C. W. “Bill” Jones Pumping Plant (herein referred to as the Jones Pumping Plant) is operated by the CVP and the Harvey O. Banks Delta Pumping Plant (herein referred to as the Banks Pumping Plant) is operated by the SWP. Water from these facilities is exported for urban and agricultural water supply demands throughout the San Joaquin Valley, Southern California, the Central

Coast, and the southern and eastern San Francisco Bay Area. The long-term operations of the CVP/SWP were included in the NMFS 2009 and USFWS 2008 BiOps, including Reasonable and Prudent Alternatives (RPA) to avoid jeopardy to listed fish species and adverse modification to their habitats. The effects of these operations are described in more detail in the applicable species accounts provided in Appendix 4.A, *Status of the Species and Critical Habitat Accounts*.

Water enters the Banks Pumping Plant via the Clifton Court Forebay. Large radial arm gates control inflows to Clifton Court Forebay during the tidal cycle to reduce approach velocities, prevent scouring of adjacent channels, and allow water to enter the Clifton Court Forebay at times other than low tide, which reduces water level fluctuation in the south Delta (U.S. Fish and Wildlife Service 2005). The Banks Pumping Plant operates to move water from Clifton Court Forebay into the 440-mile (708-kilometer) California Aqueduct. Water in the California Aqueduct travels to O'Neill Forebay, where a portion of the water is diverted to the joint-use CVP/SWP San Luis Reservoir for storage. The remaining water flows southward via the joint-use San Luis Canal, and to the South Bay Pumping Plant and South Bay Aqueduct.

The Jones Pumping Plant pumps water from Old River in the Delta into the Delta-Mendota Canal. The Jones Pumping Plant facility does not have an associated forebay. The Delta-Mendota Canal sends water southward, providing irrigation water along the way, towards the O'Neill Forebay where a portion of the water is diverted into the San Luis Reservoir. The remaining water continues in the Delta-Mendota Canal, again providing water for irrigation and refuges, as well as municipal and industrial uses, until it reaches the Mendota Pool, where water is returned to the San Joaquin River to replenish downstream flows.

The Delta Cross Channel (DCC) is operated by Reclamation. The DCC is opened to augment through-Delta flows from the Sacramento River towards the pumping facilities in the south Delta and/or to improve water quality in the central and south Delta (Figure 4-6). Two large radial gates on the Delta Cross Channel can open or close to control flows into the central Delta. When the DCC is opened, water is diverted from the Sacramento River into Snodgrass Slough and southward through the forks of the Mokelumne River. Opening the DCC increases flows, but also increases the likelihood of Sacramento Basin juvenile salmonids being entrained towards the Central Delta (Perry et al. 2012). Opening the DCC may also lead to increased straying of adult Mokelumne River Hatchery Chinook salmon, though this topic is still under investigation. During winter and spring, the DCC is often closed to keep migrating juvenile salmonids within the Sacramento River and away from the Central Delta. The DCC is also closed during flood events to reduce scour and protect downstream levees.

The Barker Slough Pumping Plant is operated by the SWP and draws water from Barker Slough into the North Bay Aqueduct (Figure 4-6). The intake is located just upstream of where Barker Slough empties into Lindsey Slough, which is approximately 10 miles (16 kilometers) from the mainstem Sacramento River. The North Bay Aqueduct is operated by DWR as part of the SWP and delivers wholesale water to the Solano County Water Agency and the Napa County Flood Control and Water Conservation District. The 27.6-mile North Bay Aqueduct extends from Barker Slough to the end of the Napa Turnout Reservoir.

The South Delta Temporary Barriers project consists of the installation of four rock barriers each spring in south Delta channels: the head of Old River, Old River at Tracy, Grant Line Canal, and

Middle River. The head of Old River barrier is also installed during the fall for dissolved oxygen reasons. The head of Old River barrier is considered a fish barrier because it is installed to keep migrating juvenile Chinook salmon in the San Joaquin River. The other three barriers are agricultural barriers, meaning they are installed to maintain water quality and water levels for agricultural uses in the south Delta. The head of Old River barrier was not installed in spring 2009 or 2010 because the U.S. Fish and Wildlife Service (USFWS) BiOp (U.S. Fish and Wildlife Service 2008) prohibited the installation of the barrier for the protection of Delta Smelt. The rock barriers are not installed in years when San Joaquin River flows are high, such as during 1998.

The CCWD diverts water from the Delta to the Contra Costa Canal and the Los Vaqueros Reservoir using four intake locations: Rock Slough, Old River, Mallard Slough, and Middle River (on Victoria Canal) (Figure 4-6). The Contra Costa Canal and its pumping plants have a capacity of 350 cfs and were built by Reclamation from 1937 to 1948 as part of the CVP. The Contra Costa Canal is owned by Reclamation but operated and maintained by CCWD. The screened Old River Pump Station (250 cfs capacity) was built in 1997 as part of the Los Vaqueros Project to improve water quality for CCWD. The Old River Pump Station connects via pipelines to a transfer pump station (200 cfs) used to pump water into Los Vaqueros Reservoir (160,000 af capacity) and from the transfer station via gravity pipeline to the Contra Costa Canal. The screened Mallard Slough Intake and Pump Station (39 cfs capacity) were constructed in the 1920s and rebuilt to make it seismically protected in 2001. It is used primarily in winter and spring during wet periods when water quality is sufficiently high. The screened Middle River Intake and Pump --Station (250 cfs capacity) were completed in 2010 to provide additional operational flexibility and improved water quality. The Middle River Intake connects to the Old River Pump Station via a pipe that crosses Victoria Island and tunnels underneath Old River. The Middle River Intake is used primarily in late summer and fall to provide better water quality than is obtainable from the other three intakes.

The effects of the operations of these Delta CVP/SWP facilities on listed species have been evaluated as part of the current BiOps for the CVP/SWP Long-term Operations (U.S. Fish and Wildlife Service 2008; National Marine Fisheries Service 2009). They form part of the baseline described in Section 4.5, *Status of the Species/Environmental Baseline Summary*, and in Appendix 4.A, *Status of the Species and Critical Habitat Accounts*.

East Contra Costa Irrigation District provides water supplies to the city of Brentwood, portions of Antioch and Oakley, the unincorporated community of Knightsen, and surrounding unincorporated rural areas. The East Contra Costa Irrigation District operates a diversion located at Indian Slough on Old River in combination with canals and pumping stations for distribution within the service area. The primary purpose of the diversion is to provide raw water for irrigation of cultivated lands, landscape, and recreational uses (e.g., golf courses). The district has agreements with CCWD and City of Brentwood to make surplus water available for municipal use.

The City of Antioch, located in eastern Contra Costa County, supplies water through diversions directly from the San Joaquin River, raw water purchased from CCWD that is delivered through the Contra Costa Canal, and treated water delivered through CCWD's Multi-Purpose Pipeline. Antioch receives approximately 85% of its water supplies from CCWD. The majority of the

water is provided for municipal and residential use, with industrial (11%) and agricultural (13%) uses in the service area.

Byron-Bethany Irrigation District provides water for agricultural, industrial, and municipal uses to portions of Alameda, Contra Costa, and San Joaquin Counties (Byron-Bethany Irrigation District 2005). The district maintains two water diversions from the Delta under a pre-1914 appropriative water right and a riparian water right on Old River. Water diversions occur from the SWP intake channel, located between the Skinner Fish Protection Facility and the Banks Pumping Plant. Two diversions serve the Byron Division and the Bethany Division. The District also operates a series of pumping stations and canals for water distribution.

East Bay Municipal Utility District's Mokelumne Aqueduct traverses the Delta, carrying water from Pardee Reservoir on the Mokelumne River to the East Bay (Figure 4-6). East Bay Municipal Utility District, in partnership with Sacramento County, constructed a major new diversion from the Sacramento River at Freeport. This new diversion, sized at 185 million gallons per day capacity, feeds into the Mokelumne Aqueduct and the Vineyard Surface Water Treatment Plant for central Sacramento County use.

There are over 2,200 water diversions in the Delta, most of which are unscreened and are used for in-Delta agriculture irrigation (Herren and Kawasaki 2001). Industrial diversions in the Delta include the Mirant Power plants at Pittsburg and Antioch. Water from these diversions cools generators producing electric power at the plants.

Suisun Bay and Suisun Marsh are important ecosystems connected to the Delta, and habitat conditions and facility operations in Suisun Bay and Marsh can affect ecosystem conditions in the Delta. A system of levees, canals, gates, and culverts in Suisun Marsh was constructed in 1979–80 and is currently operated by DWR to lower salinity in privately managed wetlands in Suisun Marsh. The Suisun Marsh Salinity Control Gates are composed primarily of a set of radial gates that extend across the entire width of Montezuma Slough. The control gates are used to reduce salinity from Collinsville through Montezuma Slough and into the eastern and central parts of Suisun Marsh, and to reduce intrusion of saltwater from downstream into the western part of Suisun Marsh. In addition to radial gates, the Suisun Marsh Salinity Control Gates consist of permanent barriers adjacent to the levee on either side of the channel, flashboards, and a boat lock. The gates have been operated historically from September to May and open and close twice a day during full operation to take advantage of tidal flows. The gates are opened during ebb tides to allow fresh water from the Sacramento River to flow into Montezuma Slough and are closed during flood tides to prevent higher-salinity water from downstream from entering Montezuma Slough. Gate operations have been curtailed in recent years to allow for salmon passage while still meeting the salinity requirements outlined within State Water Resources Control Board Decision-1641 (D-1641).

### 4.3.2.3 *Non-Water Supply Delta Infrastructure and Uses*

The Delta supports a substantial amount of infrastructure related to urban development, transportation, agriculture, recreation, energy, and other uses. Portions of six counties are included in the legal Delta: Yolo, Sacramento, Solano, Contra Costa, Alameda, and San Joaquin (California Department of Water Resources 2006).

The major land use for the Delta is agriculture, which represents approximately two-thirds of all surface area. There is increasing residential, commercial, and industrial land use in the Delta, most of which occurs around the periphery of the Delta. Major urban developments within the cities of Sacramento, West Sacramento, Stockton, Tracy, Antioch, Brentwood, and Pittsburg are in the Delta. Small towns located wholly within the Delta are Clarksburg, Hood, Walnut Grove, Isleton, Collinsville, Courtland, Locke, Ryde, Bethel Island, and Discovery Bay. Much of the development occurs in the secondary zone of the Delta.

Several interstate highways (Interstates [I-] 5, 80, 205/580, and 680) and one state highway (State Route [SR] 99) are on the periphery of the Delta, and three state highways (SR 4, SR 12, and SR 160) and multiple county roads cut across the Delta. Three major railways cross through the Delta. The Delta contains a network of electrical transmission lines (over 500 miles [805 kilometers]) and gas pipelines (over 100 lines). Natural gas extraction and storage is another important Delta use. In addition to approximately 95 public and private marinas (Lund et al. 2007), two major ports (Stockton and Sacramento) and their associated maintained ship channels are in the Delta. These ports can handle high tonnage (55,000-ton class) ships to move cargo to and from the Pacific Ocean. Much of the Delta, including 635 miles (1,022 kilometers) of boating waterways, is used for a variety of recreational purposes including water sports, fishing, hunting, and wildlife viewing (Lund et al. 2007). The effects of this infrastructure on species are described in Appendix 4.A, *Status of the Species and Critical Habitat Accounts*, as applicable.

### 4.3.3 **Reasonable and Prudent Alternative Actions under Existing Biological Opinions to Avoid Jeopardy and Adverse Modification of Critical Habitat**

The coordinated long-term operations of the CVP/SWP are currently subject to the RPAs of BiOps issued by USFWS (2008) and NMFS (2009) pursuant to Section 7 of the Endangered Species Act (ESA). Each of these BiOps was issued with RPAs to avoid the likelihood of jeopardizing the continued existence of listed species or of resulting in the destruction or adverse modification of critical habitat that were the subject of consultation in each BiOp.

**USFWS BiOp RPA.** The USFWS BiOp concluded that the long-term operations of the CVP/SWP were likely to jeopardize the continued existence of Delta Smelt and were likely to destroy or adversely modify their designated critical habitat. Therefore, the USFWS BiOp included an RPA with five components comprising three types of actions to avoid jeopardy to Delta Smelt: require a reduction in the magnitude of reverse Old and Middle River (OMR) flows to reduce smelt entrainment; implement a “Fall X2” standard requiring that X2<sup>2</sup> be located at no

<sup>2</sup> X2 refers to the horizontal distance from the Golden Gate up the axis of the Delta estuary to where tidally averaged near-bottom salinity concentration of 2 parts of salt in 1,000 parts of water occurs; the X2 standard was established

greater than 46 and 50 miles (74 and 81 km) from Golden Gate in September, October, and November of wet and above normal years, respectively, to improve rearing conditions for Delta Smelt; and implement 8,000 acres of tidal restoration in Suisun Marsh and/or the north Delta to provide suitable habitat for Delta Smelt. The OMR and Fall X2 actions have been implemented, and a portion of the 8,000 acres of tidal restoration is currently in the planning and development stage. The USFWS BiOp requires that this restoration be completed within 10 years (i.e., 2018) and several non-federal agencies are involved in implementation, including DWR and the State and Federal Contractors Water Agency (SFCWA).

**NMFS BiOp RPA.** The NMFS BiOp concluded that the long-term operations of the CVP/SWP were likely to jeopardize the continued existence of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, California Central Valley steelhead, Southern distinct population segment (DPS) of North American green sturgeon, and Southern Resident DPS of killer whale. In addition, the NMFS BiOp concluded that the long-term operations of the CVP/SWP were likely to destroy or adversely modify designated critical habitat for Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, California Central Valley steelhead and proposed (subsequently designated) critical habitat for the Southern DPS of North American green sturgeon. Therefore, the NMFS BiOp included an RPA consisting of a suite of actions that addressed Delta and upstream conditions throughout the CVP/SWP to avoid jeopardy of these species and the destruction or adverse modification of critical habitat for these species. Many of the in-Delta activities are included in the PA (Table 3.1-1).

Several components of the NMFS BiOp RPA have been implemented or are in the planning stages. Examples include the Delta operational changes that have been implemented since 2009 that are intended to reduce entrainment loss of Chinook salmon and steelhead; current planning efforts for the restoration of the Yolo Bypass; changes in water operations to improve temperature conditions for aquatic resources in the Sacramento, American, and Stanislaus Rivers; adjustments to the operations of the Suisun Marsh Salinity Control Gates and the Delta Cross Channel Gates; investigation into the efficacy of non-physical barriers in the Delta to improve salmonid survival; upstream habitat improvement projects; and a host of monitoring activities, studies, and investigations to better understand the ongoing effects of CVP/SWP operations.

Many of the RPA actions are implemented in areas that are expected to be unaffected by the PA but they provide benefits to the species addressed in this biological assessment; thereby improving the viability of the species. These include actions such as operational (including flow ramping rates) and physical habitat restoration activities in the Upper Sacramento River, Clear Creek, American River, and Stanislaus River and a Battle Creek restoration project. Additionally, several actions in the RPA include climate change adaptation measures that are difficult to quantify or measure, but that when implemented, should substantially improve the resilience of these species to climate change and the ongoing effects of the CVP/SWP.

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to improve shallow water estuarine habitat in the months of February through June and relates to the extent of salinity movement into the Delta (Jassby et al. 1995).

#### 4.3.4 Mitigation Measures Included in the 2009 State Water Project Longfin Smelt Incidental Take Permit

The 2009 SWP Longfin Smelt Incidental Take Permit (ITP) was issued by the California Department of Fish and Wildlife (CDFW) on February 23, 2009, subject to DWR's compliance with and implementation of Conditions of Approval. Several conditions have the potential to affect species addressed in this BA. Conditions include minimizing entrainment at SWP Banks Pumping Plant (Conditions 5.1 and 5.2), minimizing entrainment at Morrow Island Distribution System (MIDS) (in Suisun Marsh) (Condition 6.1), improving salvage efficiencies (Conditions 6.2 and 6.3), maintaining fish screens at North Bay Aqueduct (NBA), Roaring River Distribution System (RRDS), and Sherman Island diversions (Condition 6.4), fully mitigating through the restoration of 800 acres of inter-tidal and associated sub-tidal wetland habitat in a mesohaline part of the estuary (Conditions 7.1–7.3), and monitoring and reporting (Conditions 8.1–8.5). Conditions 5.1 and 5.2 are being implemented through DWR's participation in the smelt working group. Conditions 6.1 through 6.4 are currently being planned and implemented and are in various stages of completion. Conditions 7.1 through 7.3 are being planned consistent with the planning for restoration required for the USFWS BiOp (2008) RPA described above. Additionally, the various monitoring programs required in Conditions 8.1–8.5 are being planned or implemented consistent with the settlement agreement associated with the permit.

#### 4.3.5 Recent Drought Activities

In 2014, California experienced its third year of drought conditions. This section describes some of the key activities that have occurred. Section 4.5, *Status of the Species/Environmental Baseline Summary*, below describes the species-specific effects caused by the drought and associated activities. Water year 2012 was categorized as below normal, calendar year 2013 was the driest year in recorded history for many parts of California, and water year 2014 began on a similar dry trend (State Water Resources Control Board 2014a). In May 2013, Governor Edmund G. Brown, Jr. issued Executive Order B-21-13, which directed the State Water Board and DWR to take immediate action to address dry conditions and water delivery limitations. The Department of Water Resources and the United States Bureau of Reclamation (collectively referred to as Petitioners) filed a Temporary Urgency Change Petition (TUCP) with the State Water Resources Control Board (State Water Board), Division of Water Rights on January 29, 2014, pursuant to California Water Code section 1435<sup>3</sup>. The TUCP was conditionally approved by the State Board on January 29, 2014 and modified on February 7, February 28, March 18, April 9, April 11, and April 18, 2014, to extend and change the conditions. On April 29, 2014, the Petitioners submitted a request to the State Water Board to modify and renew the TUCP Order pursuant to Water Code section 1441, which allows temporary change orders to be renewed for up to 180 additional days. On May 2, 2014, the State Water Board issued an Order approving the April 29, 2014 TUCP modification and renewal pursuant to Water Code section 1438(a), which allows the State Water Board to issue a temporary change order in advance of public noticing requirements. The May 2, 2014 Order: (1) extended a change to Delta outflow

<sup>3</sup> A full chronology of the TUCP and all of its modifications and associated materials (e.g., biological reviews for endangered species compliance) is provided by SWRCB at [http://www.waterboards.ca.gov/waterrights/water\\_issues/programs/drought/tucp/index.shtml](http://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/tucp/index.shtml).

requirements to May and July<sup>4</sup>; (2) changed the Western Delta electrical conductivity requirement by moving the compliance point from Emmaton to Threemile Slough during May through August 15; and (3) changed the Sacramento River at Rio Vista flow requirement from 3,000 cubic feet per second (cfs) to 2,000 cfs during September through November 15 (State Water Resources Control Board 2014b). The State Board received eight Petitions for Reconsideration of the January 31, 2014 TUCP and subsequent modifications. The State Water Board denied these petitions; however, changes to the TUCP were made to improve planning and coordination based upon these petitions (State Water Resources Control Board 2014a).

As of 2015, California is in its fourth consecutive year of below-average rainfall and very low snowpack. Water Year 2015 is also the eighth of nine years with below-average runoff, which has resulted in chronic and significant shortages to municipal and industrial, agricultural, and refuge water supplies and historically low levels of groundwater. As of May 2015, 66% of the state was experiencing an Extreme Drought and 46% was experiencing an Exceptional Drought, as recorded by the National Drought Mitigation Center, U.S. Drought Monitor. Of particular concern is the state's critically low snow pack, which provides much of California's seasonal water storage. On April 1, 2015, DWR found no snow at the Phillips snow course for the first time in 75 years of early-April measurements (California Department of Water Resources 2015). The lack of precipitation over the last several years has also contributed to low reservoir storage levels in the Sacramento watershed. Lake Shasta on the Sacramento River, Oroville Reservoir on the Feather River, and Folsom Lake on the American River were at 55%, 46%, and 57% of capacity, respectively, on May 22, 2015 (64%, 55%, and 70% of average for February, respectively). Trinity Lake (water from the Trinity system is transferred to the Sacramento River system) on the Trinity River was at 36% of capacity and 48% of the February average. The San Joaquin River Watershed in particular has experienced severely dry conditions for the past three years as indicated by rainfall and snowpack (State Water Resources Control Board 2015).

As was done in 2013, California Governor Edmund G. Brown has issued a Drought Emergency Proclamation that is effective through May 31, 2016, and which directs the State Water Board to, among other things, consider petitions, such as the TUCPs to modify requirements for reservoir releases or diversion limitations that were established to implement a water quality control plan. On January 23, 2015, the Petitioners jointly filed a TUCP pursuant to Water Code section 1435 et seq., to temporarily modify requirements in their water right permits and license for the CVP/SWP for the next 180 days, with specific requests for February and March of 2015. The TUCP requested temporary modification of requirements included in State Water Board Revised D-1641 to meet water quality objectives in the Water Quality Control Plan (Plan) for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary. The TUCP requested modifications to water right requirements to meet the Delta outflow, San Joaquin River flow, DCC closure, and export limits objectives. The Petitioners requested these temporary modifications in February and March in order to respond to unprecedented critically dry hydrological conditions as California entered its fourth straight year of below-average rainfall and snowmelt runoff. The TUCP also identified possible future modification requests for the period from April to September (State Water Resources Control Board 2015).

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<sup>4</sup> The order approved modification in April and July to 3,000 cfs (instead of the 4,000 cfs that would otherwise be required).

On February 3, 2015, the State Water Board issued an order approving in part the TUCP<sup>5</sup>, subject to conditions. The State Water Board then modified the February 3, 2015 Order on March 5, 2015, and on April 6, 2015. On May 21, 2015, the Petitioners submitted a request to the State Water Board to modify and renew the TUCP Order pursuant to Water Code section 1441, which allows temporary change orders to be renewed for up to 180 additional days. A July 3, 2015 Order approved the May 21, 2015 request. On February 3, 2015, the State Water Board issued an Order that took action on the January 23, 2015 TUCP. The February Order approved temporary changes to D-1641 requirements during February and March. On March 5, 2015, State Water Board issued an Order that modified the February 3 Order in response to the January 23, 2015 TUCP. On March 24, 2015, the Petitioners requested approval of additional changes to D-1641 flow and water quality requirements through November of 2015. On April 6, 2015, the State Water Board issued an Order, which extended the changes to Delta outflow and export requirements through June, and extended the change to the DCC Gate closure requirement through May 20, 2015. On May 18, 2015 Reclamation submitted an *Updated Project Description for July–November 2015 Drought Response Actions to Support Endangered Species Act Consultations* (Project Description), *Biological Review for Endangered Species Act Compliance of the WY 2015 Updated Drought Contingency Plan for July–November Project Description* (Biological Review), *Revised Sacramento River Water Temperature Management Plan June 2015* (Temperature Management Plan), and an *Updated Biological Information for June 2015 Temperature Management Plan* to NMFS and on June 25, 2015 requested concurrence that the operations described are within the limits of the Incidental Take Statement of the CVP/SWP 2009 BiOp and serves as the Contingency Plan under NMFS BiOp Action I.2.3.C through November 2015. On July 1, 2015, NMFS concurred that Reclamation’s May 18, 2015 Project Description (with the exception of the Shasta Operations/Keswick Release Schedule, which was superseded with the June 25, 2015 Sacramento River temperature management plan) is consistent with RPA Action I.2.3.C and meets the specified criteria for a contingency plan (National Marine Fisheries Service 2015). On May 21, 2015, the Petitioners submitted a request to the State Water Board to modify and renew the TUCP Order pursuant to Water Code section 1441. The State Water Board issued an Order acting on this request on July 3, 2015.

Reclamation filed a TUCP with the State Water Board on June 17, 2015 in order to temporarily change terms of Reclamation’s permits for the New Melones Project on the Stanislaus River requiring implementation of the dissolved oxygen objective on the Stanislaus River. Specifically, the TUCP requests temporary changes to permit conditions included in State Water Board Decisions 1422 and 1641, requiring that Reclamation attain the minimum dissolved oxygen objective on the Stanislaus River below Goodwin Dam as specified in the Central Valley Regional Water Quality Control Board’s Plan for the Sacramento River and San Joaquin River Basins. This petition was approved by the State Water Board, subject to conditions, on August 4, 2015. On May 22, 2015 Reclamation submitted the Project Description and Biological Review to

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<sup>5</sup> Specifically, during February–March, the order modified minimum monthly Delta outflows to 4,000 cfs; modified minimum monthly San Joaquin River flows at Vernalis to 500 cfs; allowed the DCC Gates to be opened consistent with triggers to protect fish species; and added export constraints to allow exports of 1,500 cfs when Delta outflows were below 7,100 cfs regardless of DCC Gate status and allowed exports up to D-1641 limits when Delta outflows were above 7,100 cfs and the DCC Gates are closed.

USFWS and on June 25, 2015 submitted supplemental information to USFWS and requested concurrence that the effects of the proposed operations in the May 22, 2015 Project Description are consistent with the range of effects analyzed in the USFWS BiOp. On June 26, 2015, USFWS accepted Reclamation's determination that the effects of operations in the Project Description were consistent with the effects analyzed in the USFWS BiOp (U.S. Fish and Wildlife Service 2015).

On July 2, 2015, CDFW confirmed that the existing October 14, 2011 consistency determinations for the USFWS BiOp and April 26, 2012 consistency determination for the NMFS BiOp remained in effect and no further authorization was necessary. Additionally, CDFW confirmed that operations under the Project Description would not affect California Endangered Species Act (CESA) coverage under the Longfin ITP, and that conditions in the Longfin ITP would not be affected (California Department of Fish and Wildlife 2015). The drought conditions over the last 4 years have had substantial impacts on fish and wildlife species and their habitats. As previously noted, Reclamation and DWR submitted biological reviews of listed fish species of concern for the TUCP, in order to review species status and assess potential effects of TUCP modifications. In 2015, these reviews included the *Smelt Supporting Information for Endangered Species Act Compliance for Temporary Urgency Change Petition Regarding Delta Water Quality* (Bureau of Reclamation 2015a) and the *Salmonid and Green Sturgeon Supporting Information for Endangered Species Act Compliance for Temporary Urgency Change Petition Regarding Delta Water Quality* (Bureau of Reclamation 2015b), which were submitted as part of the January 23, 2015, TUCP. Subsequent biological reviews were provided as part of the TUCP, and covered April through September<sup>6</sup> and July through November 15.<sup>7</sup> A summary of drought effects on each species covered in this BA is provided in Section 4.5, *Status of the Species/Environmental Baseline Summary*.

Please refer to Section 3.7, *Drought Procedures*, for a discussion of how any future drought conditions will be addressed under the PA.

#### 4.4 Feather River Operations Consultation

As part of the SWP, DWR operates the Oroville Facilities on the Feather River under a license from the Federal Energy Regulatory Commission (FERC). As part of the FERC process for relicensing the Oroville Facilities, NMFS is consulting with FERC under ESA Section 7 regarding effects on listed species under NMFS' jurisdiction from FERC's proposed relicensing of the Oroville Facilities. NMFS released a draft BiOp for FERC relicensing of the Oroville Facilities in July 2009. A final BiOp is scheduled for release in spring of 2016.

The original FERC license to operate the Oroville Facilities expired in January 2007. Since then, an annual license that renews automatically each year has been issued, authorizing DWR to continue operating to the terms of the original FERC license until the new license is issued. To prepare for the expiration of the original FERC license, DWR began working on the relicensing

<sup>6</sup> See

[http://www.waterboards.ca.gov/waterrights/water\\_issues/programs/drought/docs/tucp/2015/biorev2\\_aprsep.pdf](http://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/docs/tucp/2015/biorev2_aprsep.pdf).

<sup>7</sup> See [http://www.waterboards.ca.gov/waterrights/water\\_issues/programs/drought/docs/tucp/2015/tucp052115.pdf](http://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/docs/tucp/2015/tucp052115.pdf).

process in 2001. As part of the process, DWR entered into a Settlement Agreement (SA), signed in 2006, with state, federal, and local agencies; state water contractors; non-governmental organizations; a tribal government; and others to implement improvements within the FERC boundary. The FERC boundary includes all of the Oroville Facilities, including Lake Oroville, and extends downstream of Oroville Dam to include portions of the Low Flow Channel (LFC) on the lower Feather River and portions of the High Flow Channel (HFC) of the Lower Feather River downstream of the Thermalito Afterbay Outlet. In addition to the SA, a Habitat Expansion Agreement was negotiated with NMFS and others to address the effects of the Oroville Facilities on anadromous fish in the Feather River, and to provide an alternative to NMFS and USFWS exercising their authority to prescribe fish passage under Federal Power Act Section 18.

In 2010, the State Water Resources Control Board issued the Clean Water Act Section 401 Certification for FERC relicensing of the Oroville Facilities, analyzing the SA-proposed conditions. Although the new FERC license has not been issued, it is anticipated to include the SA license terms and conditions from Appendix A and the terms and conditions of the Clean Water Act Section 401 Certification. DWR will also comply with the requirements in the NMFS BiOp after it is issued to FERC and FERC relicenses the Oroville Facilities. It is anticipated that the new FERC license will be issued for a period of up to 50 years. The FERC license and its associated agreements and permits will be the primary regulatory drivers for operations at the Oroville Facilities. Operational requirements in the forthcoming license and associated permits are expected to include minimum channel flows, water temperature, and ramping rates. These requirements will need to be met, along with any other requirements imposed on the SWP through this consultation. The analysis below describes the similarities in the proposed operations in the FERC SA and the PA, and why no conflicts between these operations is expected.

The operations modeled for the No Action Alternative (NAA) and the PA in this BA are similar to the operations modeled in DWR's BA for FERC relicensing of the Oroville Facilities. The modeling assumptions for the NAA and the PA in this BA incorporated flow requirements specified in the SA (Table 4-1). Because the NMFS BiOp for FERC relicensing of the Oroville Facilities is not yet final, the draft BiOp terms and conditions were not included in the modeling assumptions. However, for purposes of understanding potential differences between what was assumed for the modeling of the NAA and the PA in this BA and what is expected to be included in the NMFS BiOp for FERC relicensing of the Oroville Facilities on the Feather River, various flow requirements were compared (Table 4-1). As shown, the majority of assumed criteria for Feather River minimum instream flow in the NAA and the PA modeling are the same as those included in the NMFS Draft BiOp for FERC Oroville Facilities relicensing. One exception is the pulse flow target flows in March, April, and May in the NMFS Draft BiOp, which were not part of the SA and were not assumed in the modeling of the NAA and the PA in this BA.

As shown, the pulse flow targets at the southern end of the FERC boundary range from 2-day pulses to 12-day pulses of 7,000 cubic feet per second (cfs) in wet and above normal water years. Based on the input from the Green Sturgeon Technical Subcommittee of the Feather River Technical Team, two additional 2-day (48-hour) pulse flows of sufficient magnitude and duration to improve passage impediments and facilitate upstream movement of adult sturgeon may be provided. There is uncertainty as to what future pulse flow specifications NMFS might include in the Final BiOp for FERC relicensing of the Oroville Facilities because of changing

river bathymetric conditions. The 12-day pulse under the NMFS Draft BiOp in March requires approximately 165 TAF of flow released from Oroville Facilities. The two pulses in April and May require approximately 56 TAF and 28 TAF, respectively. Given that these short-duration pulse flows are limited to wetter conditions and relatively small in volume, their effect on the available coldwater pool in Lake Oroville for the months following the pulse is expected to be small. Should these pulse flow operations remain in the final NMFS BiOp for FERC relicensing of the Oroville Facilities, DWR will implement them in coordination with other SWP operations, including the PA described in this BA. Given the similarities between assumed Feather River operations criteria in the NAA and PA modeling for this BA, and the conditions in the NMFS Draft BiOp (Table 4-1), the PA is not expected to affect the ability to meet the conditions analyzed in the final NMFS BiOp for FERC relicensing of the Oroville Facilities.

Table 4-2 shows the availability of Temperature Control Actions (TCAs) from the FERC DEIR PA modeling. Because the Feather River flow requirements and all the water temperature objectives for the NAA in the current BA are the same as those analyzed in the FERC Oroville Facilities relicensing BA and the Oroville Facilities Relicensing Draft Environmental Impact Report Proposed Project Alternative (FERC DEIR PA) modeling, conditions under NAA would be similar to those of the FERC DEIR PA. Given that modeling for the PA would result in storage conditions in Oroville (Table 4-3) that would be similar to those of the NAA, as well as similar temperature conditions in the LFC (Table 4-4 and Table 4-5), conditions under the PA at the two common water temperature compliance locations, the Feather River Fish Hatchery (FRFH) and Robinson Riffle, would be expected to be similar to the FERC DEIR PA.

Even if the Oroville storage conditions under the PA were lower than the conditions that were modeled in the FERC DEIR PA, the PA would utilize the TCAs described in the SA. As noted in the Table 4-2, not all the TCAs were required to meet the temperature requirements at FRFH and Robinson Riffle under FERC DEIR PA modeling; if needed, the PA can utilize the remaining TCAs. With ability to exercise various TCAs outlined in the SA, DWR is expected to have enough flexibility to meet the minimum instream flow and temperature requirements outlined in the NMFS Draft BiOp without significantly affecting the operations resulting from the PA.

In conclusion, modeling of the Oroville Facilities conducted as part of the Oroville Facilities Relicensing EIR, BA, and draft BiOp is consistent with modeling conducted for the PA in this BA. Although the TCAs taken to achieve the water temperatures could be different under the PA modeling, flows and temperatures in the Feather River LFC and FRFH are expected to be generally similar under the PA and the NMFS BiOp for relicensing of the Oroville Facilities. Therefore, no additional analysis of those operations and associated effects is included in this BA. However, the effects of the Oroville Facilities operations are considered as part of the status of the species and critical habitat as applicable.

**Table 4-1. Feather River Minimum Instream Flow Requirements Included in the Oroville Facilities Settlement Agreement and California WaterFix BA PA Modeling Compared to the NMFS Draft BiOp.**

	<b>Oroville Facilities Settlement Agreement, and California WaterFix BA No Action Alternative and PA Modeling</b>	<b>NMFS Draft BiOp</b>
Minimum Flow in Feather River LFC	700 cfs, except from September 9 to March 31 of each year to accommodate spawning of anadromous fish release (800 cfs).	Same
Minimum Flow in Feather River HFC	Consistent with existing license and 1983 DWR-CDFW agreement (750–1,700 cfs)	Same
Additional Pulse Flows	None	In wet and above normal water years, target flows: Mar 1–12: 7,000 cfs Apr 1–30: two 48-hour, 7,000 cfs pulse flows May 1–31: one 48-hour, 7,000 cfs pulse flow In below normal and dry water years, convene Green Sturgeon Technical Team and Feather River Technical Team to determine if pulse flows are warranted. In Mar–Apr, if directed, provide two 48-hour, 2,500 cfs pulse flows

**Table 4-2. Annual Availability of Oroville Facilities Temperature Management Actions in the Oroville Facilities Relicensing DEIR PA Alternative Simulation.**

<b>Temperature Management Action</b>	<b>Number of Years Utilized</b>	<b>Remaining Years of Availability</b>
Pumpback curtailment <sup>1</sup>	74	0
Remove all shutter on the Hyatt Intake <sup>2</sup>	2	72
Increase LFC flow to 1,500 cfs <sup>3</sup>	10	64
Release 1,500 cfs from the river valve <sup>4</sup>	3	71

Source: *Oroville Facilities Relicensing DEIR Proposed Project Simulation*.  
Period of Record: 1992–1994.  
<sup>1</sup> Pumpback curtailed for at least a portion of the year.  
<sup>2</sup> All 13 shutters are removed from the Hyatt Intake.  
<sup>3</sup> For Robinson Riffle water temperature objective only.  
<sup>4</sup> For Feather River Fish Hatchery water temperature objective only; river valve is operational.